The MIPP Experiment Upgrade at Fermilab – ILC benefits $\quad$ *MIPP*

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Summary

The Main Injector Particle Production experiment (FNAL-E907)

- measures *differential particle production cross sections* of beams of π^+, π^-, K^+, K^-, p, $\bar{p}$ at 5 to 90 GeV/c and 120 GeV/c p on many targets from cryogenic hydrogen to Uranium tracking and identifying (almost) all charged particles produced.
- has taken physics data for 14 months
- is located in the Meson fixed target area MC7 at Fermilab
- is analyzing >15 million events of data
- proposed to upgrade the experiment (FNAL-P960) to speed up the DAQ and improve the detector
- can provide *unique, valuable data for ILC detector design*
- is a collaboration of ~60 people from ~20 institutions

Cross Sections for Hadronic Shower Simulation

MIPP will provide input for Hadronic Shower modeling in Geant4, MARS, Fluka, etc. Why? See Hadronic Shower Simulation Workshop (FNAL 06). Models don't work due to lack of data from experiments. (E.g. C. Meurer et. al., Cosmic ray shower discontinuity) This directly impacts ILC calorimeter design. Simulated detector performance may be wrong because the shower models are unreliable.

RICH

Calorimeter

Rosie Magnet

6 Wire Chambers

JGG Magnet

Ckov

ToF

TPC

3 BCham

2 BCkov

$$ p\,p \to p\,\pi^+\,n $$

tagged neutron: $\Delta p/p < 5\%$
pion: p_x, p_y, p_z from TPC and wire chambers
LH_2 target
beam proton: $\Delta p/p < 5\%$
low energy proton: p_x, p_y, p_z measured in TPC, Plastic Ball

Tagged Neutral Beams – Your Calorimeter Here?

MIPP can provide tagged neutral beam, i.e. neutrons, anti-neutrons, K^0 with well determined energy. The neutral particles are generated in diffractive reactions of (anti-)proton beam on LH_2 target. The energy of the neutral particle can be obtained from a *3-C kinematic fit*.

The neutral beam will have a spectrum of energies ranging from 0 to the energy of the (anti-) proton beam, but the energy of each neutral particle will be known event by event from the reaction kinematics 3-C fit.

Number of tagged neutral particles per day within 75 cm of beam axis at Calorimeter				
Beam Momentum	positive beam on LH2		negative beam on LH2	
[GeV/c]	neutrons	K0	anti-neutrons	K0
10	20532	4400	6650	4425
20	52581	9000	11450	9400
30	66511	12375	13500	14175
60	47069	15750	13550	14125
90	37600			

More details: R. Raja, *Tagged Neutron, Anti-Neutron and K-Long beams in an Upgraded MIPP Spectrometer*, MIPP-Doc-130, http://mipp-docdb.fnal.gov/

DAQ compatibility

To make use of tagged neutral beams from the MIPP experiment for your ILC Calorimeter test detector the test detector DAQ needs to work together with the MIPP DAQ. *This can be done.*
MIPP beam structure: 4 seconds of continuous beam at 2 minute intervals (and ILC: 1 ms at 200 ms intervals)
MIPP DAQ characteristics:
- pipelined DAQ: can trigger several µs after event, trigger latency is not an issue
- buffered readout: store 12k events in front-end electronics, read out & build events between spills.
Scenarios to operate a test detector DAQ in MIPP:
i) MIPP sends time-stamped trigger to test detector DAQ - if test detector DAQ trigger latency is long enough
ii) test detector self-triggers and provides a copy of its trigger to MIPP DAQ for time-stamping.
Test detector event buffer size, readout deadtimes, etc. may limit the amount of useful data that can be collected per MIPP slow spill. Simple modifications (e.g. firmware changes) in test detector readout may help a lot if use of the readout in MIPP is considered in the design. Weigh the cost to the benefit!
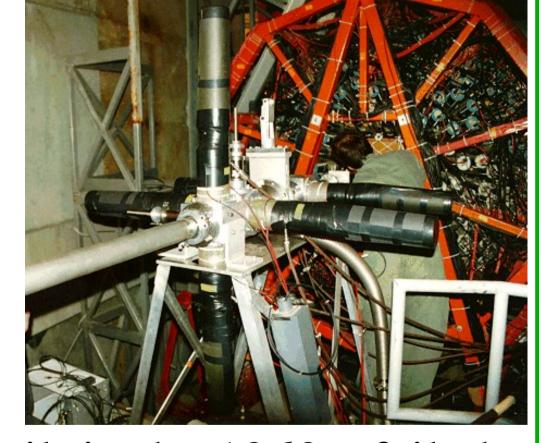
The Upgrade

Improve MIPP DAQ

TPC readout was limited to 30 Hz by old electronics. New ALTRO/ PASA chips (also used by ALICE at LHC, STAR at RHIC, ...) will get the rate to ~3kHz. This will allow to acquire *5 Million events per day* at 4 sec slow spill per 2 minutes delivered 60% of the day, i.e. less than 5% impact on other FNAL accelerator programs.

Adding the Plastic Ball for recoil particles

GSI/KVI will bring (half of) the Plastic Ball detector to put upstream of the TPC, covering the backward hemisphere around the target.

Resurrecting a Giant

The Jolly Green Giant (JGG) magnet coils, built in the 1960s, failed at the end of MIPP data taking. New coils have been designed, fabricated, and delivered to Fermilab.
The new coils are longer than the originals and will produce a more uniform magnetic field for the TPC, thus improving the already good (tenth of mm) track and vertex resolution further.

We will measure the new JGG field map using the upgraded *Ziptrack*. The new coils cost $199k M&S plus Fermilab labor for testing and installation.
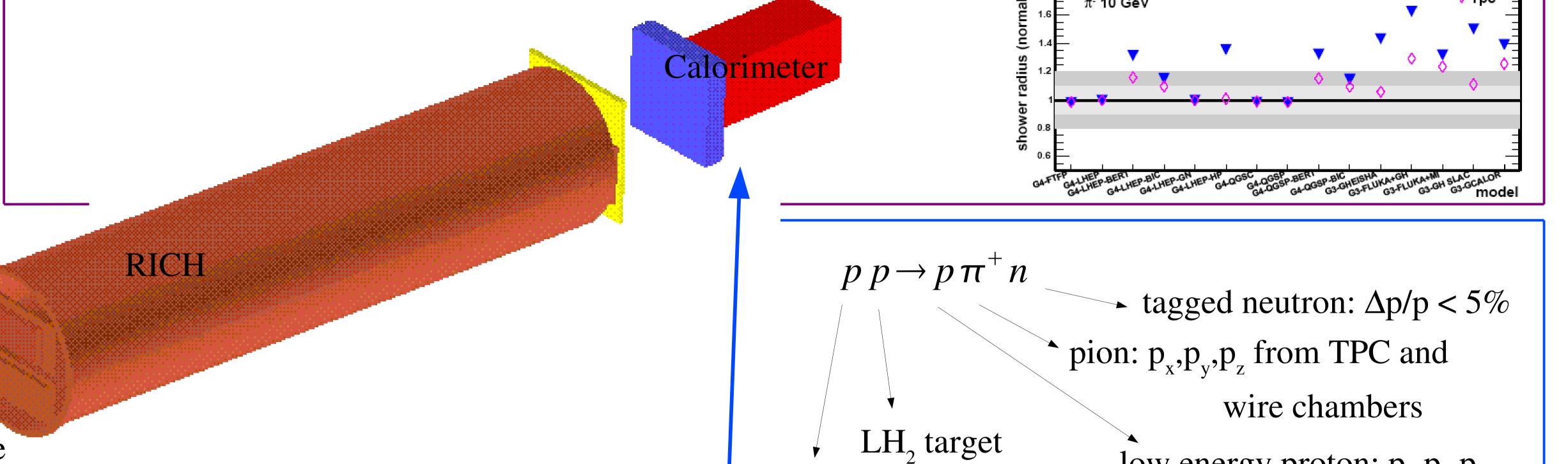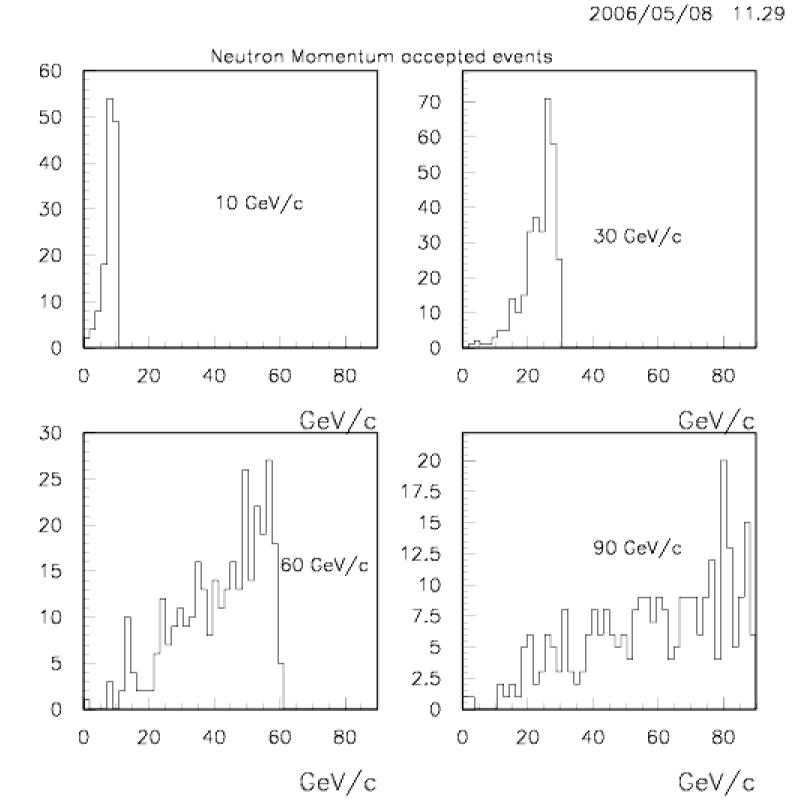Finished coil assemblies at Alpha-Magnetics before transport to Fermilab

MIPP Physics

MIPP pursues a rich physics program in non-perturbative QCD, spectroscopy, nuclear physics, lots more.
See other presentations&posters, the MIPP web-site, MIPP DocDB, etc.